obliterated, the absolute maximum occurring during the night. In six hours, namely, from 7 A. M. to 1 P. M., the increase amounted to nineteen degrees.

Michael Donovan, Esq., read a continuation of his paper "on the supposed identity of the agent in the phenomena of ordinary electricity, voltaic electricity, electro-magnetism, magneto-electricity, and thermo-electricity."

After briefly noticing the circumstances of the discovery of galvanism, the author remarked, that as soon as even a few of the facts were discovered, an hypothesis was invented to account for them; they were at once attributed to the agency of an animal electricity secreted by the brain, of which the muscles are the depositories, and the nerves the conductors. Volta admitted that the agent is electricity, but maintained that it is generated by the contact of the conductors concerned; the contraction being produced by the restoration of the equilibrium throngh the animal. Hundreds of facts have been since discovered, but, wonderful to say, the hypothesis invented before they were known has been adhered to, and is still used for their explanation.

The vast difference of properties observable in electric and voltaic phenomena has been conceived to be explicable on the supposition that in the former the quantity of electricity is small, and the intensity great, while in the latter the quantity is great and the intensity low. Several quotations from authorities were adduced to this effect, and also with a view of determining the exact meaning of *quantity* and *intensity*.

It was then argued, that the efficiency of great quantity, at a low intensity, to account for the difference between common and voltaic electricity, has been received upon grounds which have not been sufficiently canvassed; that we know nothing of quantity of electricity but by its intensity; that the two terms represent ideas which are inseparable; that intensity is the only significant condition of electricity of which

our senses take cognizance; that the expression "quantity of electricity" aims at conveying to the mind a condition which cannot be comprehended, and that, therefore, no clear idea of any explanation founded on the notion of "quantity" can be attained. Several considerations, in support of these positions, and an experiment to the same effect, were adduced. In fine, it was concluded, that there is not a known phenomenon the explanation of which receives any real assistance from the assumed agency of quantity. M. Biot, probably perceiving this defect in its alleged operation, has substituted the influence of "velocity."

Those who sought to establish identity of the different forms of electricity had long been embarrassed by the failure of all efforts to produce deviation of the galvanometer needle by means of common electricity, although it is so easily effected by voltaic. M. Colladon, imagining that this want of success was occasioned by an insufficient quantity or supply of the electric fluid, or by imperfect insulation of the coil of the galvanometer, employed one in which particular precautions were taken to insure insulation. With this instrument, placed in the circuit of a very large Leyden battery, a deviation of twenty-three degrees was obtained; the deviation increased with the intensity of the charge; it sometimes amounted to forty degrees. When the galvanometer was made part of the circuit between the conductors of a Nairne's electrical machine, the deviation was three or four degrees only; but when a coil of 500 turns, of the same construction, was substituted, a maximum deflection of thirty-five degrees was produced, provided the cylinder was made to revolve three times in a second.

Mr. Donovan then stated an experiment of his own in relation to this subject, the object of which was to prove, that in Colladon's experiments it was intensity and not quantity that acted. Other experiments were adduced to prove that, when the electricity is of the voltaic kind, the most feeble intensities are far more efficient in causing deflection of the

needle than the most powerful intensities of common electricity; showing, as it was suggested, that in the latter case the agent was electricity, which, being evolved by chemical action, contained much of the deflecting constituent element; and that in the former the agent was electricity, with its natural minimum of the deflecting constituent, because it was developed without chemical action, by mere friction; and hence the necessity of the presence of such electricity in considerable abundance to produce the required effect.

The same thing was stated to be evidenced by an experiment, in which two voltaic apparatuses were made to act separately on a differential gold-leaf electrometer, one of them producing divergence, the other none; yet the effect of the latter on the galvanometer needle was powerful, that of the former null.

Professor Faraday's repetition of Colladon's experiments on deflection by common electricity were then reviewed, and the remarkable circumstance was adverted to, that one of his deflections was produced by one pole, contrarily to the laws of voltaic electricity, in which the operation of two poles is indispensable. If it be admitted as proved, that common electricity does not require a twofold polar arrangement in order to produce deflections, it becomes a question, what is the use of the two poles used in Colladon's and Faraday's experiments with the Leyden battery? One of them must be superfluous. If this be so, we arrive at this general proposition, that voltaic electricity is composed of elements existing in such ratio, and so combined and modified, that it must be brought to bear upon the subject of its action by means of two poles simultaneously and equally energetic; while the proportions and mode of combination in the common electric fluid are such, that it produces the same effect with one pole only. Thus a difference, instead of an identity, would be proved by these experiments.

It was further observed, on Faraday's deflection of the galvanometer needle by common electricity, that no less than

2000 one-inch sparks were required to produce a deviation of forty degrees, while, in an experiment with a minute pair of zinc and platinum plates, the zinc not weighing more than the head of a pin, and probably not the thousandth part of a grain dissolved during the action of an acid on it, the needle, nevertheless, whirled round the circle twice. Thus, a chemical action, almost inconceivably small, produced an effect eighteen times greater than 2000 sparks of electricity from a powerful plate-machine. The inference drawn was, that the agents could not be the same in both.

In furtherance of the objects above detailed, Professor Faraday has made experiments to determine the quantity of electricity associated with the particles or atoms of matter; from which it may be calculated, that to decompose a single grain weight of water, 800,000 discharges of an electric battery, each discharge consisting of 300 one-inch sparks, would be required; which Faraday conceives is equal to a powerful flash of lightning: and he estimates that the electricity, that is the affinity, which maintains the oxygen and hydrogen of the grain of water in combination, is of the same amount. Thus, according to him, there is the electricity of a flash of lightning in every grain or drop of water, that is, if the electricity of a drop of water could be collected in one spark, it would be 454545 miles in length.

But Faraday neglected to compare his results with those of MM. Paets Van Troostwick and Deiman, and also with those of Dr. Pearson. These philosophers, who made experiments with the greatest care, represent the matter very differently. Many calculations were entered into, which proved that, according to the experiments of the Dutch chemists, the quantity of electricity necessary to decompose a grain of water is thirty-eight times less than Faraday's estimate, and, according to those of Pearson, forty-two times less. The vast difference of Faraday's estimate leads to some suspicions of the universality of the law as laid down by that philosopher, namely,

that if water be subjected to the influence of the electric current, no matter what the intensity or acting surface, the quantity decomposed will be exactly proportionate to the quantity of electricity which has passed. All this may be very true, when applied to the voltaic influence, but, if so, the law seems to individualize common electricity, and to dissever it from its alleged identity with voltaic electricity. When we find two estimates of an effect to agree pretty well, while a third is forty-two times greater than one, and thirty-eight times greater than the other, it is plain there is a monstrous error somewhere; and hence, before we venture to draw any conclusion, it will be necessary to investigate the grounds on which the discordant opinion has been formed. This becomes the more necessary, when it is recollected that the stronghold of those who maintain the identity of the voltaic and electric agents is the almost unlimited supply of the latter at a low intensity, which, they affirm, can be brought into action during the exhibition of any phenomenon caused by the former.

Faraday has affirmed, as already observed, that one grain of water, decomposed by four grains of zinc, can evolve electricity to an enormous amount, no less than 240 millions of one-inch sparks. To test this, an experiment was made, in which diluted sulphuric acid was made to act on a voltaic pair consisting of four grains of zinc foil and a plate of platinum, the metals being separately connected with a differential electrometer with insulated, detached, and moveable gold leaves. The solution of the zinc occupied one minute and a half, and during this period the gold leaves were rapidly approached until they touched, and then rapidly withdrawn; there was not the slightest attraction or repulsion, although, according to Faraday's estimate, the equivalent of 240 millions of one-inch sparks was passing between them at the time. Yet, when the same electrometer was subjected to the action of a voltaic series, consisting of twenty pairs of three-quarter-inch plates, both attraction and adhesion took place.

Lest it should be supposed that this quantity had been really evolved, but was lost by dissipation, an experiment was made, in which a voltaic pair, the zinc weighing four grains, was made to act as above described, the whole being contained in a hermetically sealed glass vessel, with an electrometer so constructed that it would indicate the smallest quantity of dissipated electricity; but there was not the slightest appearance of such.

Should it be affirmed that the alleged enormous quantity of electricity was produced, but, being in the positive and negative states, they neutralized and destroyed each other, the following experiment was opposed to the supposition. A plate of zinc was connected with a plate of platinum, by means of an inch of platinum wire $\frac{1}{100}$ inch thick: this was included in a glass sphere with dilute sulphuric acid, the glass being hermetically sealed. When the acid was made to act on the zinc, there was not the least appearance of heat in the platinum wire, resulting from the neutralization of the alleged enormous quantity of the two states of electricity; nor were any traces of electrical action on the electrometer discoverable. If, according to the hypothesis, the equivalent of 240 millions of positive and negative one-inch sparks had passed through the platinum wire, at the rate of 1,600,000 per second, need it be inquired what would have become of the wire and the whole apparatus. Van Marum, with one discharge of his battery, melted forty feet of thin iron wire.

The supporters of the doctrine here objected to may maintain that the alleged quantity of electricity was really in operation, but that it was retained and concealed in the constitution of the resulting gases; and this also seems to be the opinion of Faraday, by his adoption of the electro-chemical theory of Berzelius, wherein he expresses his belief that the light and heat evolved during combination are produced by the discharge of positive and negative electricity which at that moment takes place. If in the seven or eight cubic inches of

mixed oxygen and hydrogen, which result from the decomposition of a grain of water, there be electricity concealed equal to 240 millions of one-inch sparks, when the mixture is detonated, so as to recompose water, a flash of lightning and clap of thunder ought to be the consequence, instead of the little bright flame and the trivial crack which occur.

But it is not merely this immense quantity of electricity that is unaccounted for. Professor Faraday conceives that the electricity which holds the elements of a grain of water in combination, enormous as its quantity is affirmed to be, can only be overcome, during decomposition, by an equal quantity of electricity. What then becomes of this second portion? What has become of the first? We have not been able to discover traces of either. No less than 480 millions of one-inch sparks are concerned in the decomposition of one grain or drop of water, and we can find no account of any portion of them.

Mr. Donovan thus concludes this portion of his paper: "I conceive that the rules of discussion warrant my running this hypothesis as closely to the impossible as I can. The higher the authority, the stronger must be the argument to give it any chance of success. It is on this account that I take the liberty of reasoning thus freely on the opinions of so celebrated a philosopher."

The President and Dr. Apjohn made some remarks on Mr. Donovan's communication, in opposition to his views, and confirmatory of the received doctrine of the identity of electricity from different sources.

DONATIONS.

A Silver Hiberno-Danish Coin and a Bronze Celt, found at Newington, County Kildare. Presented by James Forbes, Esq.

The Twenty-sixth Report of the Leeds Philosophical Society, for 1845–6. Presented by the Society.